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The Effect of Virtual Blended Learning Models with PhET Assistance on Students' Mastery of Concepts in Fluid Material

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Abstract: This study aims to determine the effect of blended learning virtual learning models on PhET-assisted fluid material on students' conceptual comprehension. The design model used in this research is an experiment with a pretest-posttest type. The sample used in this study was Class XI IPA C as the experimental object consisting of 35 students in one class. The test given was in the form of a concept comprehension ability test consisting of 10 multiple choice questions with a maximum score of 100. The results showed that the average posttest score was higher than the average pretest score in the experimental class. In addition, an N-gain value of 0.62 was obtained, which means that the value of increasing student learning outcomes using the phet-assisted virtual blended learning model is in the medium category. This shows that the use of PhET-assisted blended learning virtual models has an effect on students' mastery of concepts.

Keywords: Mastery of concepts; PhET; Virtual blended learning

Introduction

Learning natural sciences allows students individually or in groups to actively seek, explore, and discover concepts and principles in a comprehensive and real way. One of them is physics lessons, where students are directed to search and find themselves so that it can help to gain a deeper understanding of physics. Students are trained to be able to discover for themselves various concepts that are studied thoroughly, meaningfully, authentically, and actively. Based on the facts in class physics material is considered difficult by students. This tendency usually starts from their learning experiences where they discover the fact that physics lessons are lessons related to concept issues, understanding concepts, and solving complex problems through a mathematical approach (Abriani et al., 2016; Erlinda et al., 2020).

So far, the physics learning process tends to be teacher centered with learning methods that tend to be monotonous and do not involve students in finding a concept in the learning process (Kuspriyanto et al., 2013; Mustofa et al., 2016). Such learning creates ignorance in students about the processes and attitudes of physics concepts that are obtained very low and it is necessary to apply learning models that can improve learning outcomes (Pinilih et al., 2016). Therefore, it is necessary to change the paradigm of the learning process. The paradigm change in question is a change from teacher centered learning to student centered oriented learning (Tyas et al., 2020). This emphasizes students to be actively involved in the learning process as students who are active in learning have a different understanding from students who are less active. Because learning physics is learning that is difficult to understand because there are many formulas that are difficult to understand plus learning physics is less attractive to students because there are no simulations related to learning physics. Several studies show that students still have difficulty understanding concepts (Azizah et al., 2021; Experenza et al., 2019; Rohim et al., 2012).

To improve student learning outcomes related to students' understanding of concepts, especially understanding physics concepts that are more in-depth and there are no errors during learning, then in learning, a model is used that can make students actively involved directly through practicum/experiments or direct

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observation (Hendri et al., 2016; Mudjiono, 2022; Rustaman, 2005; Wenning, 2012). The focus of the learning model is not to present the final concept to students, but rather to students building or discovering the concept through practicum or experiments and direct observation so that an assimilation process occurs in it to connect experiences or information that students already have with what students are learning (Rifa'i et al., 2012).

The experimental method is a way of delivering subjects by conducting experiments so that students experience and prove for themselves something that is learned. The experimental method can be used as a method used by teachers to involve students in discovering and applying important concepts in physics. With the experimental method, students are invited to work through the scientific method and be able to act scientifically in applying physics concepts (Okpatrioka et al., 2022). The application of the experimental method can make physics learning outcomes more meaningful and meaningful because students experience and prove something that is learned in learning for themselves (Juraini et al., 2016).

According to Tsaniyah et al. (2019) that blended learning combines conventional educational methods (face to face) with learning supported by technology. Model learning like this is known as blended learning. Development and research on blended learning has been carried out by many experts such as Purnomo et al. (2017), Widiara (2018), and Idris (2018), stating that blended learning is preferred over traditional classes because blended learning gives satisfaction. Husni et al. (2010) stated that understanding of the concept of static fluid material after participating in web-assisted learning increased.

With blended learning students' mastery of concepts is better. Bawaneh (2011) states that blended learning can improve student performance. This can be seen from the increasing number of students who are online in learning, as well as conducting online discussions. Blended learning that combines face-to-face and e-learning methods can involve students actively and allows students to receive feedback. In line with this, Graham et al. (2005) stated that blended learning can improve pedagogy, access and flexibility, as well as cost-effectiveness. Welsh et al. (2003) stated that blended learning supports the benefits of e-learning including cost reduction, time efficiency, and convenient places for students to understand personally in important issues and can provide motivation when face-to-face learning, whereas Nurkamto et al. (2019) stated that blended learning has the advantage that students have a lot of time to study under the guidance of the teacher. Setiawan (2019) states that web-based learning is able to foster students' independence in constructing their own knowledge, indicated by an increase in mastery of concepts, an increase in generic science and students giving good responses.

At a time when the whole world is being hit by the Covid-19 pandemic which has forced all teaching and learning activities through face-to-face meetings to be virtual face-to-face with the help of the internet. With the existence of the blended learning model, the virtual face-to-face learning process can be said to be the development of a distance learning model to prevent the wider spread of Covid-19, which has made the government think hard about handling this situation by issuing Law no. 6 of 2018 related to Health Quarantine, then strengthened by PP no. 21 of 2020 and Permenkes 9 of 2020 concerning Large-Scale Social Restrictions (PSBB). With the existence of these PSBB rules, like it or not, there is a transition of learning methods from offline to online including learning Physics. In addition to technical problems faced by students, such as signal difficulties and the absence of devices to access virtual learning. This raises new problems in the process of teaching Physics concepts and principles, especially in the form of experimental practices or experiments in the laboratory which before the pandemic required physical interaction.

According to Garner et al. (2015), blended learning is a learning environment that is designed by bringing together face-to-face (F2F) learning with online learning that aims to improve student learning outcomes and will increase students' understanding of physics concepts. According to Rijal et al. (2015) the development of information technology has had a positive impact on the learning process such as using virtual experiments as an alternative to overcoming the limitations of physics laboratory facilities, especially in Physics learning activities during a pandemic.

To facilitate the teaching and learning process and complement the shortcomings of previous researchers, an online PhET simulation based blended learning model will be used combined with interesting simulations. One of the physics learning models through virtual practicum which is known today is PhET (Physics Education Technology). PhET which will be developed into PhET simulation-based blended learning allows students to learn independently by doing virtual physics simulations outside of school or at home. In this way, students can connect the information they already have with what students have learned through simulation experiments so that they can build or discover the basic concepts of physics learning materials.

In the context of this pandemic, the use of virtual laboratory media such as PhET is not to replace the role of an actual laboratory (real laboratory). However, as an alternative complementary solution to limited physical access and incomplete laboratory facilities and equipment in schools, namely at SMAN 7 Mataram which is one of the oldest vocational schools in the province of West Nusa Tenggara.

Method

This study used a quantitative research method with a quasi-experimental research design. This study aims to determine the effect of blended learning assisted by PhET simulation on students' mastery of concepts on the topic of static fluid learning which is considered to be a lack of understanding. The research subjects were students of class XI IPA in the 2019/2020 academic year at a high school in Mataram. The number of students as many as 37 students. Before being taught using the PhET simulation-assisted blended learning model, all students are given an initial test that aims to find out the initial knowledge students have. Then given a final test to determine the increase in mastery of the concept. The test given is in the form of a concept comprehension test which consists of 10 multiple choice questions with a maximum score of 100 and covers the cognitive domains C1-C5, namely understanding, applying, analyzing and evaluating. The increase in learning outcomes is measured by the N-gain test using equation 1. The N-gain calculation results obtained are matched with the N-Gain table. The N-Gain values consist of high categories (N-gain> 0.7), medium (0.70 > N-gain ≥ 0.30), and low (N-gain <0.3) (Sugiyono, 2017).

$$\text{N} - \text{gain} = \frac{S_{post} - S_{pre}}{S_{max} - S_{min}} \quad (1)$$

Result and Discussion

The data obtained in this study were in the form of pre-test and post-test data which showed students' mastery of the concept of static fluid material studied in class XI students in odd semesters. Concept understanding data was obtained from a test instrument consisting of 10 multiple choice questions with a maximum score of 100 and covering the cognitive domains C1-C5, namely understanding, applying, analyzing and evaluating. The pre-test and post-test values are shown in table 1.

Based on table 1, it can be seen that the average pre-test score was 38.71 and the average post-test score was 76.71. This means that the post-test score is higher than the pre-test score in the experimental class. In addition, based on the table it can be seen that the N-gain value is 0.62. This means that the value of increasing student learning outcomes using the PhET-assisted blended learning model is in the medium category. This shows that the use of the PhET-assisted blended learning model has an effect on students' mastery of concepts.

Table 1. Pre-test and Post-test Grades of the Experiment Class

Class	Pre-test	Post-test	N-Gain	Interpretation of N-Gain
Experiment	38.71	76.71	0.62	Medium

Based on the results of research data analysis with sample tests using questions and simulations, the results showed that there were differences in the ability of students to master the concept of students who took part in the pre-test and post-test who were treated using blended learning using a simulation, and it can be interpreted that there were differences in students' conceptual mastery of static fluid material quite significant between the pre-test and post-test scores. The difference in the average ability to master the concept between the two samples shows that there is an influence from the difference in the treatment carried out during the learning process in class X1 IPA C.

The change in mastery of the concepts produced in the research that occurred was caused by several factors, namely in the early stages of learning students were presented with a problem in the form of a simulation contained in the PhET learning media. This stage has the aim of knowing the extent of students' prior knowledge based on the problems presented. Teachers and students carry out question and answer sessions related to these problems. The ability of students to interpret problems between different group members shows that there is collaboration between students in describing each problem item. After being given a problem the teacher explains the activities carried out according to the instructions in the simulation, students form groups and collect data. In this stage the activities carried out by students are testing hypotheses through experimental activities. Students and their group members collaborate in making experiments, making observations on experiments carried out and collecting data independently. This can involve cognitive processes so that there is an increase in students' mastery of concepts (Kaniawati, 2017). At this stage students' understanding of concepts can increase because students are able to estimate the relationship between variables by testing the truth of the hypothesis proposed (Tiruneh et al., 2017).

At the experimental stage students are guided to conduct experiments together with group members. It is at this stage that students are asked to collect data and are expected to be able to find or form concepts at the data processing stage. At this stage it is carried out by asking students questions to understand the concepts in the pressure material. Each group holds discussions that are useful for examining the data obtained from the experimental results and connecting them with what will be done in data processing. The questions contained in the questions have a function to direct students to build knowledge through learning experiences and direct students to connect the results of experiments with appropriate conclusions and guide students to information (Zamista et al., 2015). The last stage is the teacher gives the opportunity to representatives of group members to present the results of the experiment they get, and other group members pay attention. The group that did not progress could compare the results of the experiment and ask if the results did not match what was presented. Each group presented the results of the discussion in turn. This process can train students to think and ask questions and can develop critical thinking skills (Novtiar et al., 2017).

Conclusion

Based on the results of the analysis, it can be seen that the average posttest score is higher than the average pretest score in the experimental class. In addition, an N-gain value of 0.62 was obtained, which means that the value of increasing student learning outcomes using the phet-assisted blended learning model is in the medium category. This shows that the use of PhET-assisted blended learning models has an effect on students' understanding of concepts.

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